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54 An electric air heater.

57 An electric forced-convection air heater consisting of an axial fan (1,6) and a cage-shaped resistance heating element (2) mounted upstream of the fan impeller (1), which serves to heat the air passing there through and to guide the air stream smoothly to the impeller (1). The cage shaped resistance heating element (2) comprises a plurality of spaced longitudinal strips (61) of uniform width, extending parallel to the axis of the cage; the surface of each strip is inclined to the ideal cylindrical surface of the cage and is curved perpendicular to its long axis. The alternate ends of the adjacent strips are joined by bridging portions (62) of the same material, but of larger cross section. Each bridging portion (62) is perforated by a small opening. The cage is rigidly held in its cylindrical shape by two end rings of a thermoplastic material, provided with outstanding lugs (73') on their circumference, one lug each engaging with one of the openings in the bridging portion (62) atop each end of the cage.

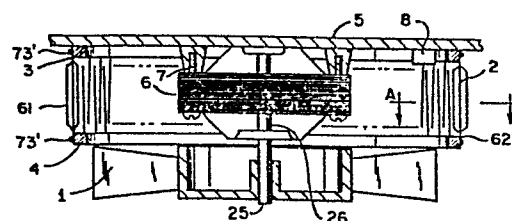


FIG. 1

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AN ELECTRIC AIR HEATER

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Background of the Invention

15 The invention relates to an electric forced-convection air heater suitable for permanent attachment to a wall or a ceiling, or as a freestanding room heater. It refers particularly to an electric air heater provided with an axial fan and an electric resistance heater mounted upstream of the fan impeller.

20

Most forced-air heaters of known design employ as heating elements coils of resistance wires suspended from ceramic supports which, in turn, are held in position by a metal structure. This kind of heating element is very labor intensive, since the coils have to be threaded through openings
25 in the ceramic supports, a task which is necessarily carried out by manual labor.

30

Another kind of resistance heater consists of individual strips of a resistance alloy, threaded at their both ends into perforations of ceramic support members. The projecting ends of the strips are subsequently connected to an electric power source by soldering or clamping. It will be understood that this assembly is highly labor intensive and therefore, expensive.

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U.S. Patent 4 090 061 discloses a resistance heater surrounding a centrifugal blower impeller and serving both as air heater and as outlet guide

1 vanes. The heater is in form of a cage of parallel vanes which are at
their alternate ends connected to the adjacent vanes by bridging pieces.
The cage is positioned in circular recesses in opposite walls of the
blower casing and held therein by friction and pressure. The manufacture
5 of this heating element is labor-saving, but the position of the individual
vanes in relation to each other and to the blower casing is not very
exact and stable, frequently resulting in changes of the angle of
incidence and of the spacing of adjacent vanes. In a heater of that kind
the air stream traverses the guide vanes radially from the inside to the
10 outside, resulting in an omnidirectional output airstream. In order to
obtain a heated airstream focussed in one main direction it is necessary
to provide special casings and further guide vanes which are expensive,
difficult to manufacture and tend to cause eddies and thus noise in the
airstream.

15 US-Patent 2 221 703 discloses a heater in which air is drawn in in radial
direction between a plurality of circumferentially disposed electrically
heated fins. The air is drawn to an axial fan impeller, situated in the
center of the heater at some distance in front of the plane in which the
20 fins are located. The air is then expelled in one main direction. In a
heater of that kind the rotating impeller fan causes the air upstream and
downstream the impeller to rotate in the same sense as the impeller,
thus reducing the efficiency of the fan and causing undesired turbulence.

25

Summary of the Invention

It is the object of the present invention to provide an electric forced con-
vection air heater which should serve to provide an airstream focussed in
30 one direction, with the further aim to reduce the flow resistance of the
heater elements to a minimum, thereby lowering the noise level of the
appliance and to increase its efficiency.

It is a further object of the invention to provide a resistance heater of a
35 rigid construction and of simple design which should lend itself to manu-
facturing at low cost.

- 1 Still another object is to obviate the brittle and expensive ceramic supports utilized in most conventional heaters and made necessary by the high temperatures experienced, and to use, in their stead, supports from a plastic material which are simple to manufacture and can be readily assembled without danger of breakage.

And it is a final object to provide a fan unit and a resistance heater of standard design, which can be used together with a considerable number of casing designs for different heating purposes.

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- The forced convention air heater according to the invention, consists essentially of an axisymmetrical casing containing an electric motor and an axial impeller, a cage shaped resistance heater, surrounding the electric motor at a predetermined distance, both the motor and heater being in axisymmetrical alignment. The unit likewise contains means for electrically energizing the electric motor and the heater, and means for controlling the current supply to the heater as a function of the air temperature.

- 20 In a preferred embodiment of the air heater the fan casing comprises a rigid back plate, a front portion perforated by air outlet openings, and a peripheral portion containing air inlet openings. The fan motor is firmly connected to the backplate in coaxial alignment with the casing, and an impeller is firmly mounted on the motor shaft, facing the outlet openings in the front portion of the casing.

- The resistance heater is in the form of a cage fastened in a peripheral gap of the casing upstream of the fan impeller; it comprises a plurality of spaced, longitudinal strips of an electric resistance alloy in sheet form, all strips being of uniform width and extending parallel to the axis of the cage; the surface of each strip is inclined to the surface of the cage and is curved perpendicular to its long axis. The alternate ends of adjacent strips are jointed by bridging portions of the same material, but of larger cross section, whereby current density becomes much less than in the strips and causes the bridging portions to remain relatively cool. Each bridging portion is perforated by an opening of preferably rectangular shape, all bridging portions and all openings being of

1 identical shape and location in regard to the conductive strips.

The cage is rigidly held in its predetermined shape by two end frames of a thermoplastic material which have an outside perimeter coextensive with the inside of the metal cage and are provided with outstanding lugs on their circumference, one lug each engaging with one of the openings in the bridging portions at each end of the cage. For the purpose of firmer engagement the ends of the lugs are molten down on the bridging portions by heating after assembly, thus preventing any movement of the connected parts due to thermal expansion or vibrations.

Electric terminals, a thermo-fuse and a thermostatic limit switch are preferably mounted on one of the end frames.

15 With a view to the obtaining a strong cage at low cost, the entire cage including the strips and the bridging portions are cut and formed from a single sheet of resistance alloy by means of manufacturing processes known to the art. The bridging portions lie in one common plane initially, while the strips are bent, all in the same direction and at a uniform angle of incidence in relation to the plane of the bridging portions. At a later stage the cut and formed sheet is wrapped around the two end frames so as to form a complete cage, the ends of the lugs are placed into the openings of the bridging portions and are heated, whereby they melt down around the openings and firmly lock the cage and the end frames.

In order to compensate for thermal expansion of the strips it is advisable - as known to the art - to firmly connect one end frame only to the casing, leaving the other frame freely movable in axial direction.

30 Around these basic components, i.e. the motor and impeller and the resistance heater, a casing of any size and design may be conceived, either as a wall-and ceiling fan heater, or as a free-standing room heater.

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1 Short Description of the Drawings

FIGURE 1 is a cross section through a backplate, a motor and an impeller, and a resistance heater, forming the basic components of the electric heater of the invention,

FIGURE 2 is an enlarged longitudinal section through a portion of the resistance heater along line A-A of FIGURE 1,

10 FIGURE 3 is a section along line B-B of FIGURE 2,

FIGURE 4 is a cross section through a backplate, motor and impeller, and the resistance heater, showing shielding and cooling means for the electric motor, and an alternate heater fastening means,

15

FIGURE 5 is a cross section through a portable room heater and a support structure, incorporating the basic components of FIGURE 1,

20

FIGURE 6 is a frontal view of the room heater of FIGURE 5 as indicated by arrows C-C,

FIGURE 7 is a cross section of a wall heater incorporating the basic components of the heater of FIGURE 1,

25

FIGURE 8 is a cross section of a room heater, wherein the basic components are incorporated in a casing of larger size,

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FIGURE 9 is a plan view of part of a sheet of a resistance alloy, stamped out in the shape of the longitudinal strips and the bridging portions,

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FIGURE 10, is a section through part of the resistance heater, showing terminals and electric control components fastened to one of the end rings, and

FIGURE 11 is an enlarged longitudinal section along line D-D of FIGURE 4, showing additional means for securing the heater strip to the end

1 rings.

Description of the Preferred Embodiments

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Referring now to FIGURES 1, 2 and 3 of the drawings, the basic components of the air heater consist of an axial impeller 1 mounted on the shaft 25 of an electric motor 6, a resistance heater 2 in the shape of a cylindrical cage, and a back plate 5. The motor 6 is attached to the back
10 plate by bolts 7.

The resistance heater consists of a plurality of parallel curved strips 61, all inclined at the same angle of incidence and interconnected at alternate ends by flat bridging portions 62. The strips are inclined in such a
15 manner that the air drawn in between them is rotated in opposite sense in relation to the rotation of the axial fan impeller. Therefore the airstream expelled by the fan is almost a pure axial stream, which is smooth and nearly free from rotation and turbulence. Each bridging portion is perforated by a rectangular opening 63 (FIG. 6), and these heater
20 components are cut out of a whole sheet of a resistance alloy and bent into cylindrical shape. The cylinder is supported at its both ends by two end rings 3 and 4 of a thermoplastic material which contain a plurality of outstanding lugs 73 located on their periphery at distances corresponding to the distances between the openings 63 in the bridging portions, and of a cross section permitting their insertion into these
25 openings, one after the other.

After interlocking of the openings and lugs, the tops of the latter are heated and molten down onto the bridging portions around the openings,
30 as can be seen on the left hand side of FIGURE 2 and FIGURE 3.

FIGURE 1 shows that only one of the end rings (3) is fastened to the back plate, while the second end ring is free to move in axial direction, in order to prevent stresses in the strips 61 owing to thermal expansion.
35 A thermostatic limit switch 8 is seen to be attached to the backplate.

FIGURE 4 illustrates a similar assembly as FIGURE 1, with the addition

1 of a cylindrical guard 22 positioned around the motor 6 and attached to
the back plate. The guard protects the motor and its bearings 26 against
overheating by the air heated on its passage through the heater strips 61;
the motor is additionally cooled by ambient air entering through several
5 openings 21 provided in the back plate, the air being drawn in by the
suction of the fan 1. It will be understood that, while fastening this kind
of fan to a wall or ceiling, a gap is to be left between the back plate
and the wall surface permitting air to reach the openings 21.

10 FIGURE 4 also shows a secondary ring 11 which serves to secure the
heater cage to rings 3 and 4.

The basic components illustrated in FIGURES 1, 2 and 3, are incorpora-
ted in the room heater shown in FIGURES 5 and 6, with the addition of
15 a frontal casing III, serving to shield the heating element and the fan
impeller from contact by the user. The casing is attached to the back
plate 5 and comprises a tubular fan shroud 32 closed at its front by a
grille 31 in the shape of concentric rings, and an air inlet portion in
form of annular, parallel spaced fins 33 which surround the heater cage
20 at a distance.

A metal support 35 serves to support the casing at a distance from the
floor and is attached to the back plate by means of two sleeves 34,
which also permit the support to be separated from the heater whenever
25 necessary.

FIGURE 6 shows the arrangement of the electric control equipment in
the casing (in broken lines), viz. a thermostatic switch 36, a multi-stage
switch 37, and the electric connection to a power cord 38.

30 FIGURE 7 illustrates a heater the casing of which is similar to that
shown in FIGURES 5 and 6, but attached to a wall or ceiling. It will be
noted that both the inlet and the outlet grilles are slightly different in
design from those illustrated in FIGURES 5 and 6, but that the basic
35 components are identical in both cases.

FIGURE 8 is a vertical section through a room heater of larger dimen-

1 sions which, again, incorporatess the basic components of FIGURE 1.
Herein the casing is composed of two halves, a front part 55 and a rear
part 56, connected along their circumferential portions. The front part
has a flat face which is perforated by outlet openings 53, while the flat
5 rear wall of the rear part is perforated by air inlet openings 52. A fan
shroud 54 forms part of the front portion and extends from the front
wall to the end ring 4 of the heater cage, leaving only a small circular
gap between these parts permitting axial expansion of the cage. The
back plate 5 also serves as a heater support ring and is fastened to the
10 rear wall of the casing by posts 51 and screws 58. Legs 59 support the
casing on the floor.

FIGURES 9 and 10 illustrate details of the resistance heater and its as-
sembly. FIGURE 9 shows several conductive strips 61 connected by bridg-
15 ing portions 62 as they appear after stamping and forming from a flat
sheet of a resistance alloy.

The bend lines 64 are created by the twisting and forming of the strips
61 out of the plan in which the bridging portions 62 remain.

20 The bridging portion 62 are of much larger cross section than the conduc-
tive strips 61, resulting in a lower temperature; the cross sections of
both the strips and the bridging portions are to be designed so that the
temperature of the latter does not affect the material of the end rings.
25 A rectangular opening 63 perforates each bridging portion which serve as
anchors for the lugs 73 positioned on the respective peripheries of the
end rings.

FIGURE 10 illustrates the assembly of the cage on the end rings 3 and 4.
30 In order to facilitate the assembly, the two rings are preferably mounted
- during assembly only - at their correct distance on a rotatable struc-
ture, whereby the position of the lugs 73 is staggered in respect to the
two rings so as to conform to the position of the openings 63 in the
bridging portions as shown in FIGURE 9. In order to start the assembly
35 the two frist bridging portions at the end of a - still planar - cage are
placed with their openings on a pair of lugs on the two spaced rings, and
the lugs are melted down on the metal as indicated by the numeral 73'.

- 1 The process is continued, the cage strip is gradually bent around the rings and the heads of all the following lugs are similarly melted, firmly connecting the cage to the rings. FIGURE 10 also illustrated the arrangement of the electric connections to the both ends of the cage.
- 5 For this purpose one of the two end rings is provided with two inwardly extending ears 76 which are provided with clamping means for the electric leads in the form of parallel spaced ribs 79.

10 A thermostatic limit switch 8 in series with a thermo-fuse 9 are fastened to one of the ears and connected to one end portion 62' and to a lead 75 by opposite terminals, while a second lead 78 is connected to the other end portion 62. The two leads are, in a known manner, connected to a switch which energizes both the heating element and the fan motor.

- 15 FIGURE 11 illustrates yet additional means for securing the heater strip to the end rings. The basic end ring 4 is similar to the rings shown in FIGURES 1, 2 and 3, and so is the heater strip as illustrated in FIGURE 9. In order to retain the strip in its place an outer ring 11 featuring internal teeth 12 is placed over the end ring 4 so that the internal teeth
- 20 12 firmly hold the bridging portions 62 between the rings 4 and 11.

It will be understood that the basic components as well as the casing may undergo variations and modification at the hands of a person skilled in the art without, however, deviating from the spirit of the invention

25 and the scope of the offended Claims.

For instance, the cage need not be a circular cylinder, it might be an elliptical or square cylinder or not even a complete cylinder as long as the void portion is blocked by means of a solid wall.

- 30 The back plate is not necessarily of planar configuration, but may be designed in a manner suitable for incorporation in a specific casing as long as suitable connection points are provided for the attachment of the motor and the heating element.

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CLAIMS

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1. An electric forced-convection air-heater having an axial fan impeller (1) mounted on the shaft (25) of an electric motor (6) and spaced electrically heated elements (2) mounted upstream of the fan impeller (1) substantially along the jacket of an ideal cylinder which is coaxial to the shaft (25), characterized in that the heated elements (2) consist of a plurality of flat strips (61) extending in axial direction and being equally inclined about their longitudinal axes in relation to the tangent of the jacket such that the airstream drawn in between them is caused to rotate opposite to the rotation of the fan impeller (1).

20

2. Air-heater according to claim 1, characterized in that the fan impeller (1) is mounted at an axial position immediately adjacent to the axial position of the heated elements (2).

25

3. Air-heater according to claim 1 or 2, characterized in that each strip (61) is curved in cross section.

30

4. Air-heater according to claim 3, characterized in that the tangential plane at the outer long side of each strip (61) is located approximately in radial direction and the tangential plane at the inner long side is located close to the circumferential direction of the jacket of the cylinder.

35

5. An electric forced-convection air-heater consisting of an axial fan in the form of an electric motor (6) and an axial fan impeller (1) mounted on the shaft (25) of said motor, of a cage-shaped electric re-

- 1 sistance heater (2) mounted on a common base with said fan, upstream
of said fan impeller (1) in coaxial alignment therewith in a manner
permitting air to be drawn by said fan impeller (1) through said cage and
to be heated by said resistance heater (2), and of means (37, 38) for elec-
5 trically energizing said motor (6) and said resistance heater (2), wherein
said cage-shaped resistance heater (2) consists of a plurality of spaced
longitudinal strips (61) of an electric resistance alloy, of substantially
uniform width extending substantially parallel to the axis of said fan, the
surface of each strip (61) being inclined to the ideal enveloping surface
10 of said cage, said strips (61) being held in a predetermined angle of
inclination by conductive bridging portion (62) of the same material but
of larger cross section than said strips, said bridging portions (62)
jointing the alternate ends of each two proximate strips (61) so as to
form a resistor circuit in a zig zag pattern, said cage being held in shape
15 and position by two supporting frames (3, 4) of a heat-resistant and
non-conductive material, each frame being firmly connected to all
bridging portions at one end of said cage, and holding said bridging
portion in spaced-apart electrically insulating alignment.
- 20 6. The electric heater of Claim 5, wherein said cage is of cylindrical
configuration of a larger inner diameter than said fan impeller (1), and
wherein said supporting frames (3, 4) are of a circular annular shape.
- 25 7. The electric heater of Claim 5, wherein one of the two supporting
frames (3, 4) also serves as a mounting plate for said fan.
- 30 8. An electric forced-convection air heater consisting of a casing
comprising a rear portion, a front portion provided with air outlet
openings (53), and a peripheral portion provided with air inlet openings
(52), an axial fan positioned inside said casing in coaxial alignment, com-
prising an electric motor (6) and an axial fan impeller (1) mounted on the
shaft (25) of said motor (6) downstream of said air inlet openings (52) in
said casing,
an electric resistance heater (2) in the shape of a cylindrical cage
35 fastened inside said casing in coaxial alignment, said cage being of larger
cross-section than said impeller and comprising a plurality of spaced
longitudinal strips (61) of an electric resistance alloy in sheet form,

1 serving both as heating elements and as air guide vanes, of substantially
uniform width extending substantially parallel to the longitudinal axis of
said cage, the surface of each strip (61) being inclined to the ideal
cylindrical surface of said cage, said strips (61) being held in a
5 predetermined angle of incidence by conductive bridging portion (62) of
the same material but of larger cross section than said strips (61), said
bridging portions (62) jointing the alternate ends of each two proximate
strips (61) so as to form a resistor circuit in a zig zag pattern, at least a
portion of said bridging portions (62) being provided with cut-outs (63)
10 and all bridging portions at both ends of said cage being positioned in
common cylindrical planes in spaced alignment,

ring shaped supports (3, 4) for the two ends of said cage shaped
resistance-heater of a non-conductive and heat resistant material firmly
connected to said bridging portions by means of said cut-outs (63) in said
15 bridging portions,

means (37, 38) for electrically energizing said axial fan to cause air
to flow through said resistance heater (2) and through said casing into
the surroundings to be heated, and

means (37, 38) for electrically energizing said resistance heater (2)
20 to a temperature adequate for heating the air passing through said
impeller.

9. The electric air heater of Claims 5 or 8 wherein said conductive
strips (62) of said cage are curved in a direction perpendicular to their
25 long axis so as to improve the air flow between said strips (61) to said
impeller and to increase the rigidity of said strips (61).

10. The electric air heater of Claim 8 wherein said ring shaped sup-
ports (3, 4) consist of one ring each of an outside diameter coextensive
30 with the common cylindrical plane formed by said bridging portion (62)
and provided along its circumference with outstanding lugs (73) corres-
ponding in size and location to said cut-outs (63) in said bridging portion
(62), serving to locate and secure said cage by interlocking with said
cutouts (63).

35

11. The electric air heater of Claim 8 wherein said two end rings (3, 4)
are of a thermoplastic material and wherein at least a portion of said

- 1 outstanding lugs (73) are enlarged at their outer ends after assembly by heating and melting, so as to firmly hold said bridging portions (62) in exact position.
- 5 12. The electric air heater of Claim 8 wherein each of said bridging portions (62) is perforated by said cut-outs (63), and wherein said two end rings (3, 4) are provided with one outstanding lug each to interlock with the corresponding cut-outs (63).
- 10 13. The electric air heater of Claim 8 wherein a first end ring (3) is rigidly fastened to said casing, and wherein the second ring (4) is free permitting axial expansion of said conductive strips (61) due to temperature changes.
- 15 14. The electric air heater of Claim 8 wherein said conductive strips and said bridging portions (62) are integrally formed from a single sheet of resistance alloy sheet.
- 20 15. The electric air heater of Claim 8 wherein said rear portion of said casing is in the form of a solid backplate (5) serving both for attachment of said electric motor (6) and of said first end ring of said cage.
- 25 16. The electric air heater of Claim 8 wherein said electric motor (6) is laterally surrounded by a cylindrical shroud (22) in order to protect it against heating by the hot air, and wherein said back plate (5) is provided with perforations (21) extending into the space inside said shroud (22), permitting ambient air to be drawn into said shroud (22) cooling said electric motor (6).
- 30 17. The electric air heater of Claim 14 wherein a frontal casing is attached to said back plate (5) provided with peripheral air inlet openings (52) in the form of annular, parallel spaced fins (33) and with concentric air outlet openings (53) facing said fan impeller (1) downstream thereof.
- 35 18. The electric air heater of Claim 14 wherein at least one of said end rings of the resistance heater is provided with inwardly extending ears (76), serving to support a thermostatic limit switch (8), a thermofuse, and the leads carrying electric current to the terminals of said cage.

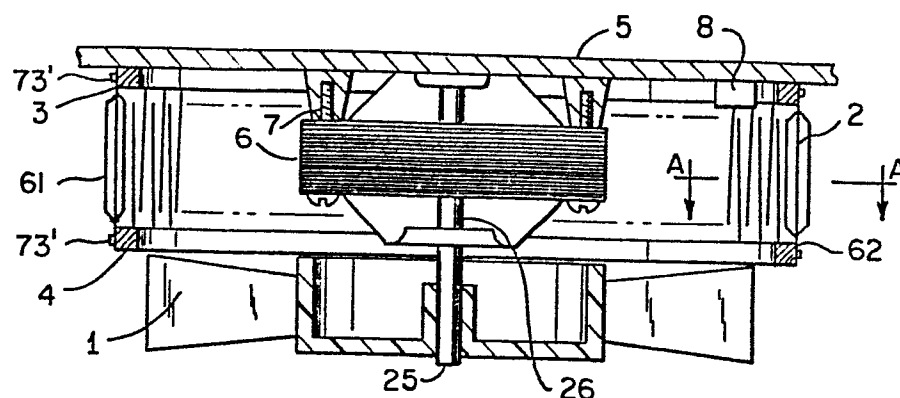


FIG. 1

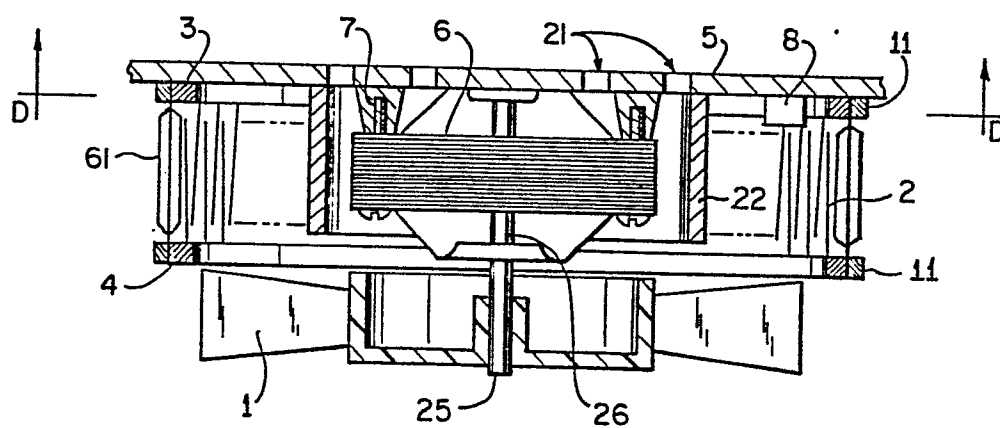


FIG. 4

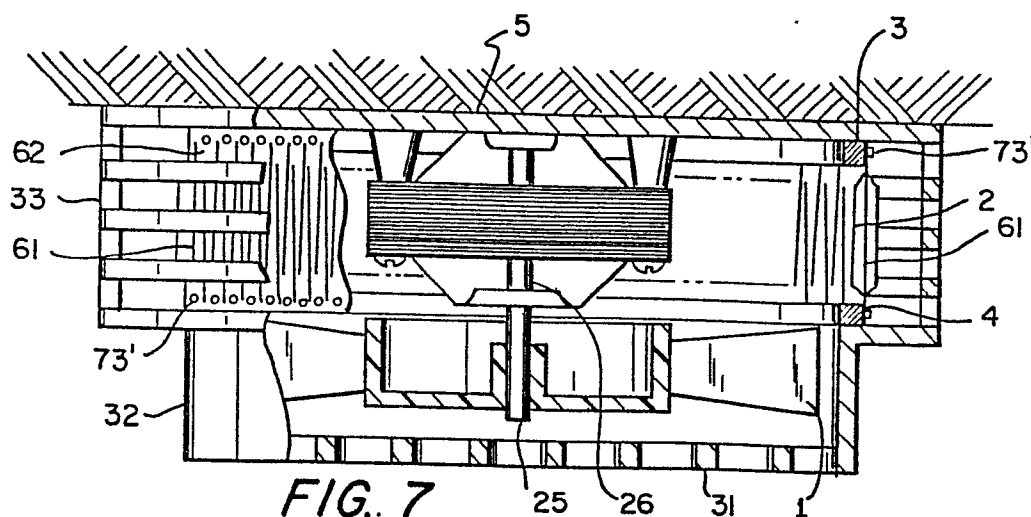


FIG. 7

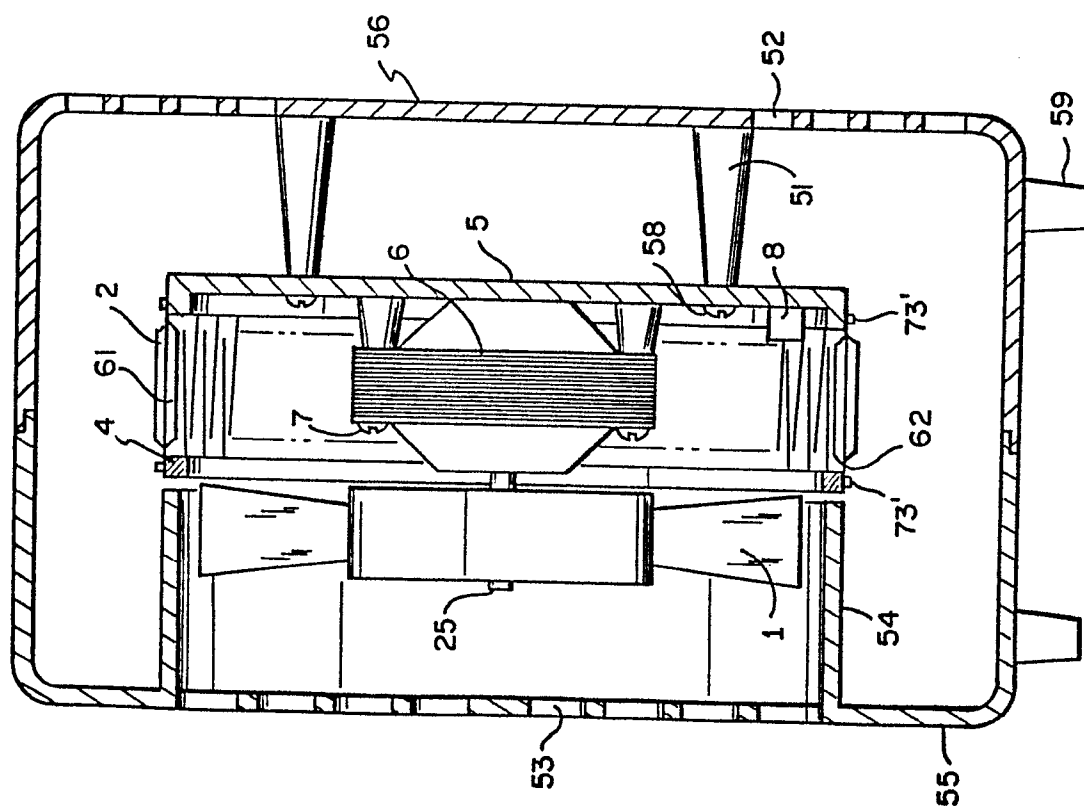
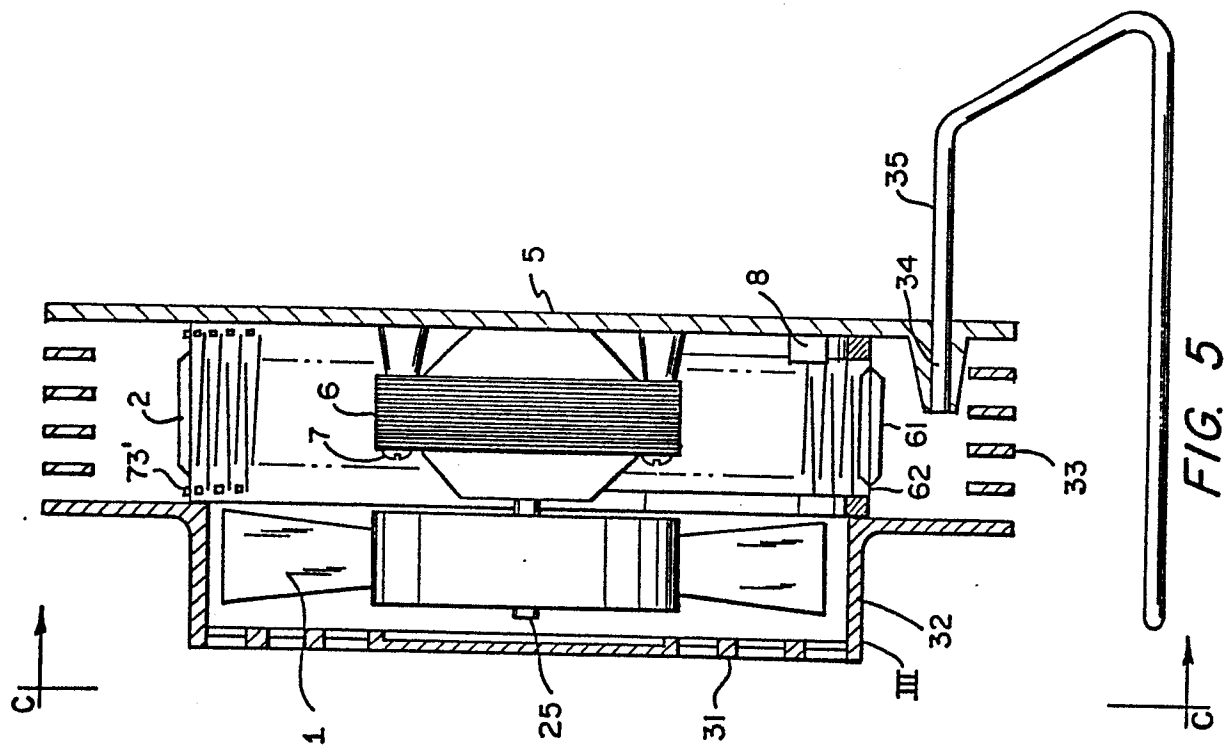


FIG. 8

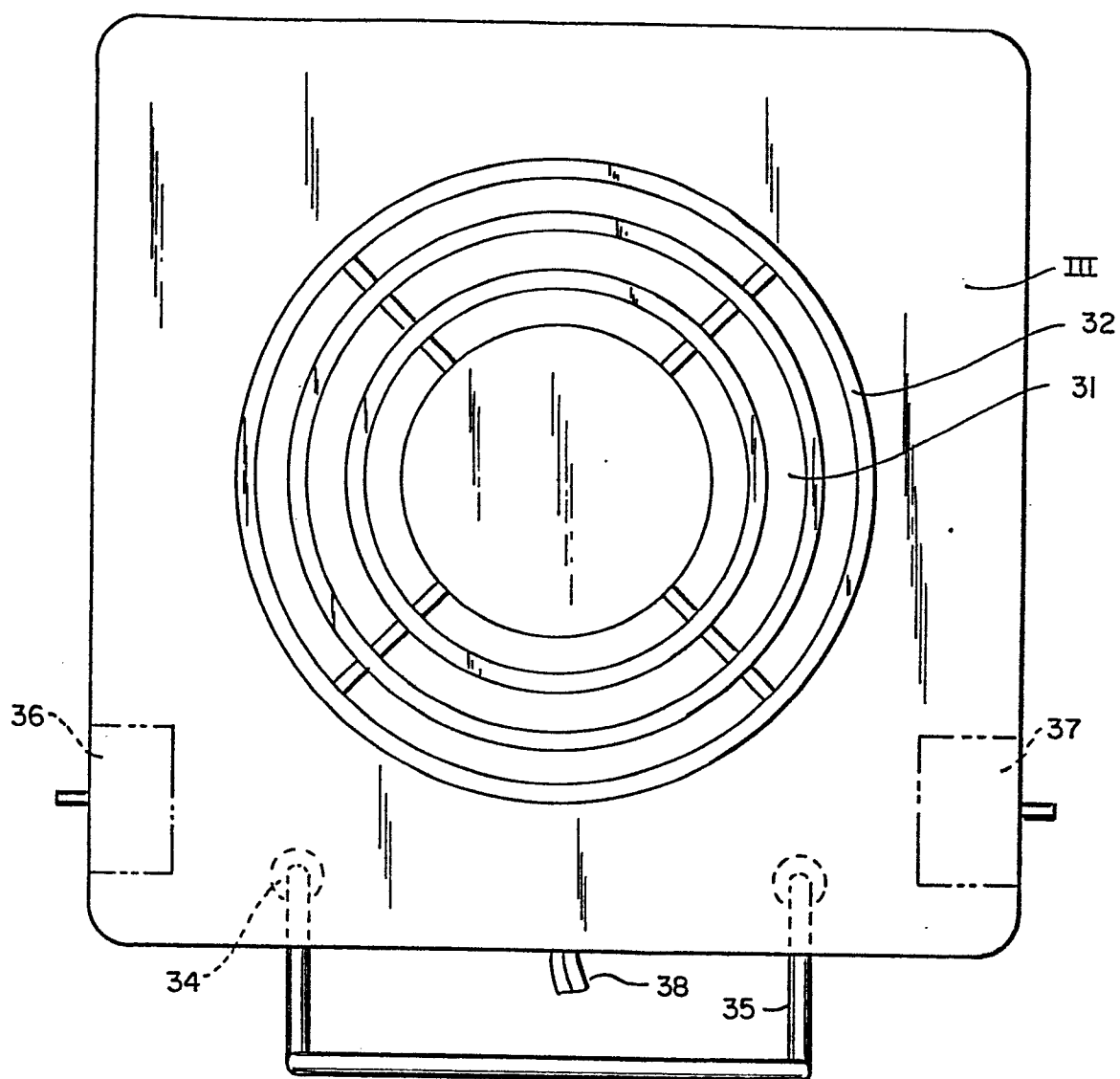


FIG. 6

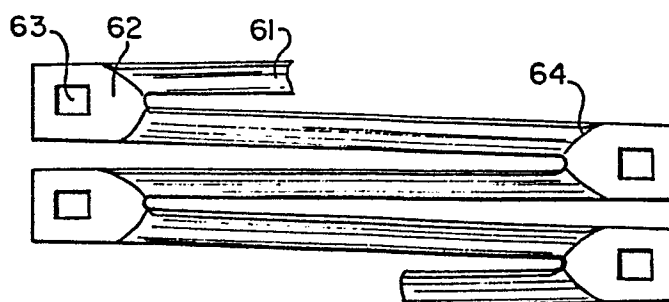


FIG. 9

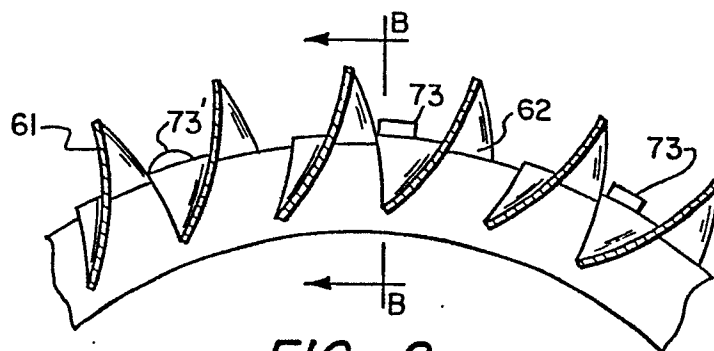


FIG. 2

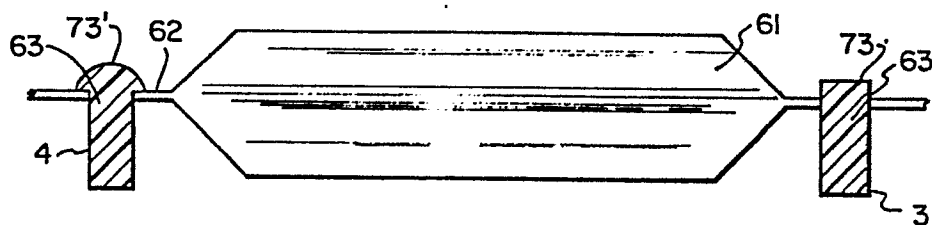


FIG. 3

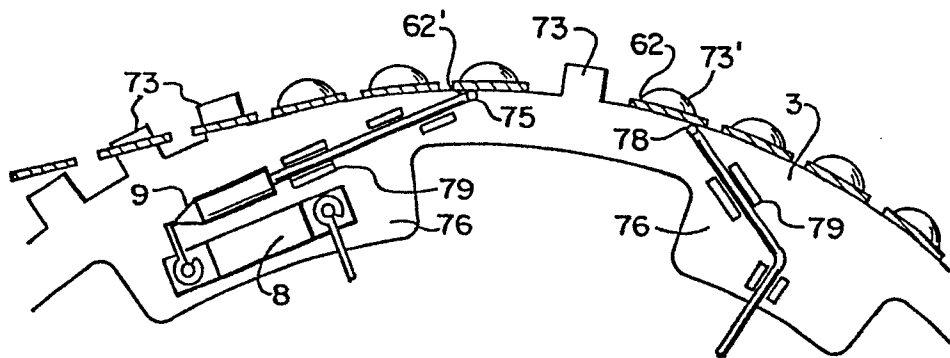


FIG. 10

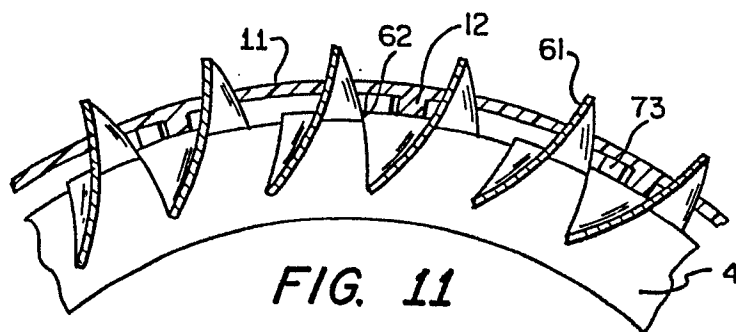


FIG. 11